COMMENTARY

Points of View: Does Endangered *Chorizanthe valida* Do Better With Grazing?

As a former investigator of environmental plasticity and population characteristics of rare and common annual plants under differing conditions (e.g., Hickman, Journal of Ecology 63:689–701, 1975 and 65:317–326, 1977), and because *Chorizanthe valida* S. Watson is such a sensitive taxon, I feel the need to respond to Davis and Sherman (Madroño 39:271–280, 1992).

I am in strong sympathy with detailed studies of endangered plants. Although I believe that Davis and Sherman's findings can be considered suggestive, they have not yet shown clearly that livestock grazing provides "a positive influence on the perpetuation of a rare, endemic plant" (Abstract, p. 271). The problem resides in interpreting the population feature they measured and in variables not addressed.

Green-plant density was the only population parameter measured in Davis and Sherman's study. It was emphasized at the urging of state and federal agencies (Davis and Sherman personal communication 1992). Unfortunately, density alone is an unreliable indicator of population success in plastic annuals (as it is in unthinned forest stands). I have confirmed repeatedly in annuals that the highest densities and ± uniformly small size are found in the most marginal environments. Some tiny, highly stressed annuals have had densities exceeding 30,000/m^2, but density was in no way a predictor of their "success."

Small, dense plants from grazed plots are shown in Davis and Sherman's Figure 3A. They set few seeds per individual and fit the general pattern produced by greater stress from some environmental factor. I deduce that they were unable to grow large enough to experience much competition for light or water.

The plant in Figure 3B (from a grazing exclosure) is robust and produced many seeds, as is expected under more benign physical conditions, and with moderate competition. The illustrated plants strongly suggest (against Davis and Sherman's assertion) that *C. valida* is a reasonable competitor. Furthermore, Davis and Sherman (personal communication 1992) suggested (from Bodega Bay rainfall data) that *C. valida* had done better in wetter years, under lusher conditions.

In 1989, individual plants in exclosures did much better than those outside: they have been estimated by Davis and Sherman (personal communication 1992) (and by me from information in their paper) to have set 6–10 times more seeds per unit area, despite their initial and continuing significantly lower density. Relative sizes were more or less comparable in 1991 (Davis and Sherman personal communication 1992), when ungrazed density was only 4% that of grazed, yet seed production was about half that of the grazed plots.

I have claimed that an annual plant is a seed's way of making more seeds—seeds and their dynamics are the greatly predominant part of the annual life cycle. Seed production is of much more importance to the success of annuals than is density.

Annuals have seed-storage mechanisms of various sorts. (Davis and Sherman [personal communication 1992] found germination to be difficult under greenhouse conditions, which is expected if there is seed storage.) This is compatible with the accepted advantages of the annual habit in marginal and unpredictable environments. One consequence of seed storage is that green-plant density sometimes has little to do with the numbers of seeds produced the previous year. Years of zero establishment can be followed by years of high green-plant density from stored seeds (fire annuals are a spectacular example).

Seed fates (as well as numbers) are thus of critical importance, however difficult

they are to study. Seeds were produced by virtually all (even tiny) green plants each year, which is in line with other observations. In ungrazed plots, either 1) a higher proportion of seeds died before green-plant establishment or 2) more seeds were stored in the soil, possibly timed variably for germination ("bet-hedging" against bad years) or awaiting growing seasons with favorable conditions. Alternative 2) might well be best for perpetuating the species, so some answer to the seed-fate question is needed before Davis and Sherman's primary conclusion is justified.

If the higher density in grazed plots were simply due to reduction of competition by grazing, these plants would not be so small. The question of why they were is not easily answered, but the fact does indicate a harsher environment. As they are avoided by cattle, grazing is not directly responsible. However, trampling by cattle in such sandy soils is almost certain to cause root breakage, decreasing water and nutrient availability.

If the precipitous density crash in ungrazed plots in 1990 were due to competition from palatable or perennial plants inside the exclosures, the significant rebound of 1991 would be unlikely. The crash in 1990 could have been caused by seed-storage vagaries or by abnormally high but undetected mortality of pre-establishment seedlings. Mortality patterns of germinants also need study.

These unresolved issues are caveats to Davis and Sherman's primary conclusion that grazing helps *Chorizanthe valida.* In fact, the information they presented may be interpreted as indicating that the opposite conclusion is correct. Until more data are available, especially concerning seeds and their fates, basing a management plan on their conclusion would be unwise.

Plant population dynamics is an inherently difficult area of study; nevertheless, it is the only way to understand what helps or hurts a population through time. Thought must be given to, and care must be taken in, measuring those features that are of most importance to the population under study conditions. Research sponsors and funding agencies for rare plant studies should be made aware that simplistic study requirements may eventually prove deleterious or even disastrous to the subjects of study.

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ANNOUNCEMENT

Beginning 1 January 1994, all new manuscripts and correspondence concerning previously submitted manuscripts should be addressed to the new editor:

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